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A Silvicultural Planting Key for Lowland Sites in Southern Ontario

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The silvicultural planting key is an aid for reforesting lowland sites in southern Ontario. Such factors as elevation, pH, plant cover types, drainage, and silvicultural treatments are presented in a dichotomous key. Incorporated within this key are listed the recommended tree species to plant, post planting care of the plantation, possible damage by animals and probable planting results on each of the planting sites. Silvical and silvicultural features of swamp tree species, silvicultural instructions and a glossary are presented under separate headings. The data supporting the key are based on 28 years of study on 19 lowland sites.

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INTRODUCTION

The silvicultural planting key was prepared as an aid to foresters forest technicians and private landowners who are engaged in the reforestation of the swamp and bottomland sites south of the Precambrian Shield in the Province of Ontario. It is based on a simple dichotomous key in which a particular feature and its alternative are given the same capital letter and degree of indentation throughout.

The most over-riding feature is given the letter A and its alternative *A*. Under A, the next most important feature and its alternative are given the letter B and indented, the next feature and its alternative the letter C and indented further, and so on. As such, A appears once, B twice, C four times, D eight times, etc. Likewise, under the letter *A*, the features are indented and identified by the letters *B, C, D, etc*. To facilitate use of the key, the page number of the alternative feature is indicated.

By working through the key from A to F (or *F*), the would-be-planter can completely identify the planting site as to elevation, pH, plant cover type, drainage, silvicultural treatment, tree species to plant, post-planting care, possible damage by animals and probable planting results.

The information within this key is derived primarily from silvical and silvicultural data that I have collected since 1958 from hardwood and conifer plantations established on a variety of swamp and bottomland sites in southern Ontario (Fig.1). Soil data such as pH, free lime and texture were analysed from all planting sites by the Site and Productivity Unit, Ontario Forest Research Centre, Ontario Ministry of Natural Resources. The influence of temperature on growth and survival of the various swamp tree species and their cultivars are jointly expressed in the key by elevation (Fig.1) and by the Growing Degree-Days (GDD) of the planting sites of southern Ontario (Fig.2).

Data collected since 1965 on tree species planted on these lowland sites, and on trees in several natural stands, indicated that growth and survival decreased with increasing elevation and decreasing GDD. Exceptions will sometimes occur in frost pockets. For example, in open portions of the Winchester Bog, where the elevation is only 91 m (297 ft) with 3200 GDD, both silver maple and jackii poplar clones experienced die-back each fall over a five year period from early fall frosts. However, no die-back occured in this area when the same tree species were planted in openings in a trembling aspen stand.

After the SILVICULTURAL PLANTING KEY, a section on the SWAMP TREE SPECIES describes only those silvical and silvicultural features of each species which will assist the user in deciding what species would best meet the particular site and economic requirements of the area. SILVICULTURAL INSTRUCTIONS explain in detail the most efficient methods of applying the most important silvicultural steps in reforesting the lowland sites. The GLOSSARY was prepared as a convenient reference to the technical terms used in the key. The index of SCIENTIFIC AND COMMON NAMES OF TREES, SHRUBS AND SEDGES, MOSSES AND HERBS referred to in the report is included to minimize mistakes in identification and to serve as a reference for anyone wishing additional information from systematic botany and forestry handbooks. The publications listed in the BIBLIOGRAPHY were used not only in the preparation of the glossary, silvicultural instructions and description of the tree species, but also in constructing the silvicultural planting key.

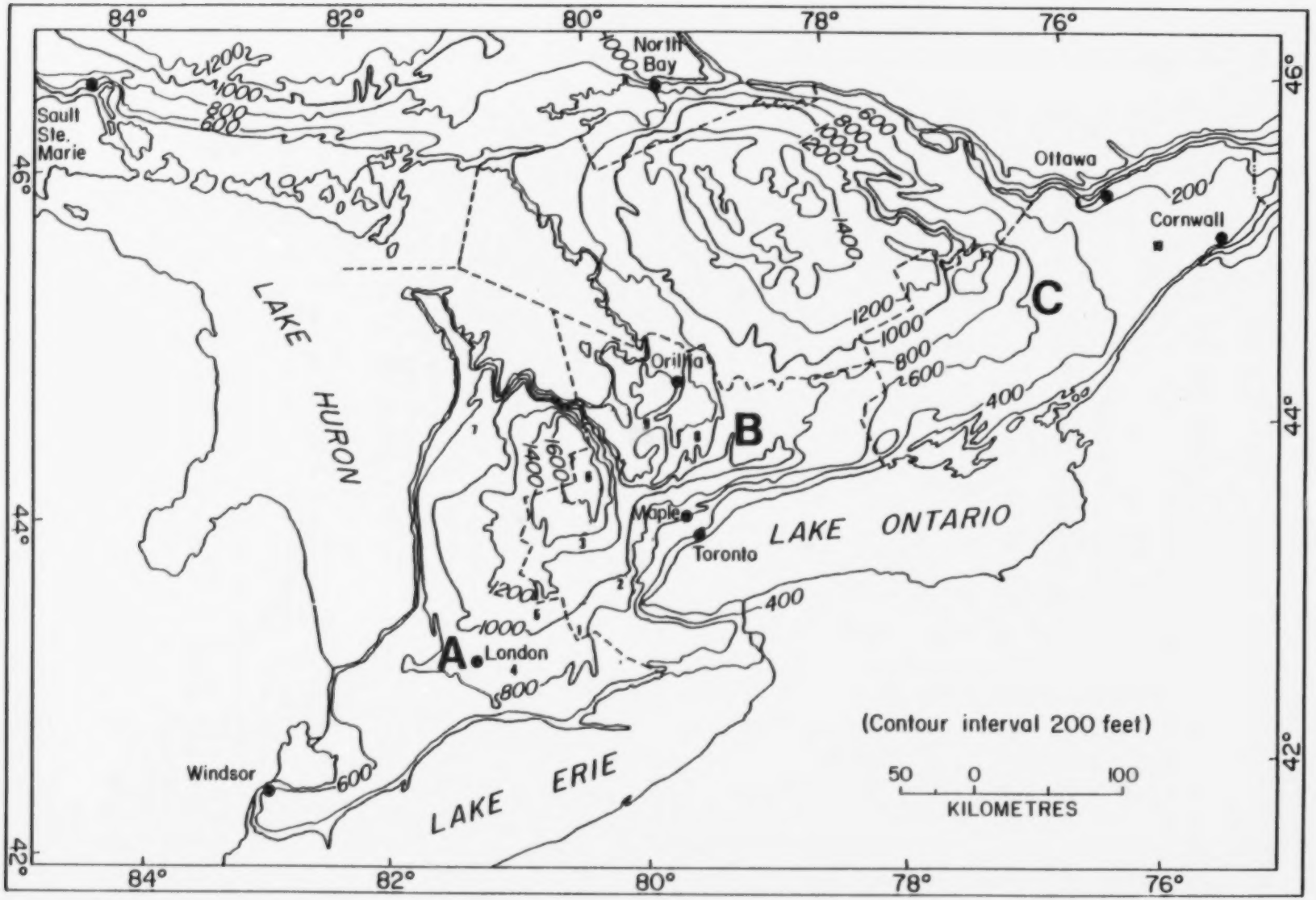

Figure 1 Topographic map of southern Ontario including regional boundaries of the Ministry of Natural Resources (A Southwestern, B Central, C Eastern) and location of areas used to develop key (1 Burford, 2 Beverly, 3 Puslinch, 4 Dorchester, 5 Ellice, 6 Luther, 7 Greenock, 8 Mathew, 9 Minesing and 10 Winchester)

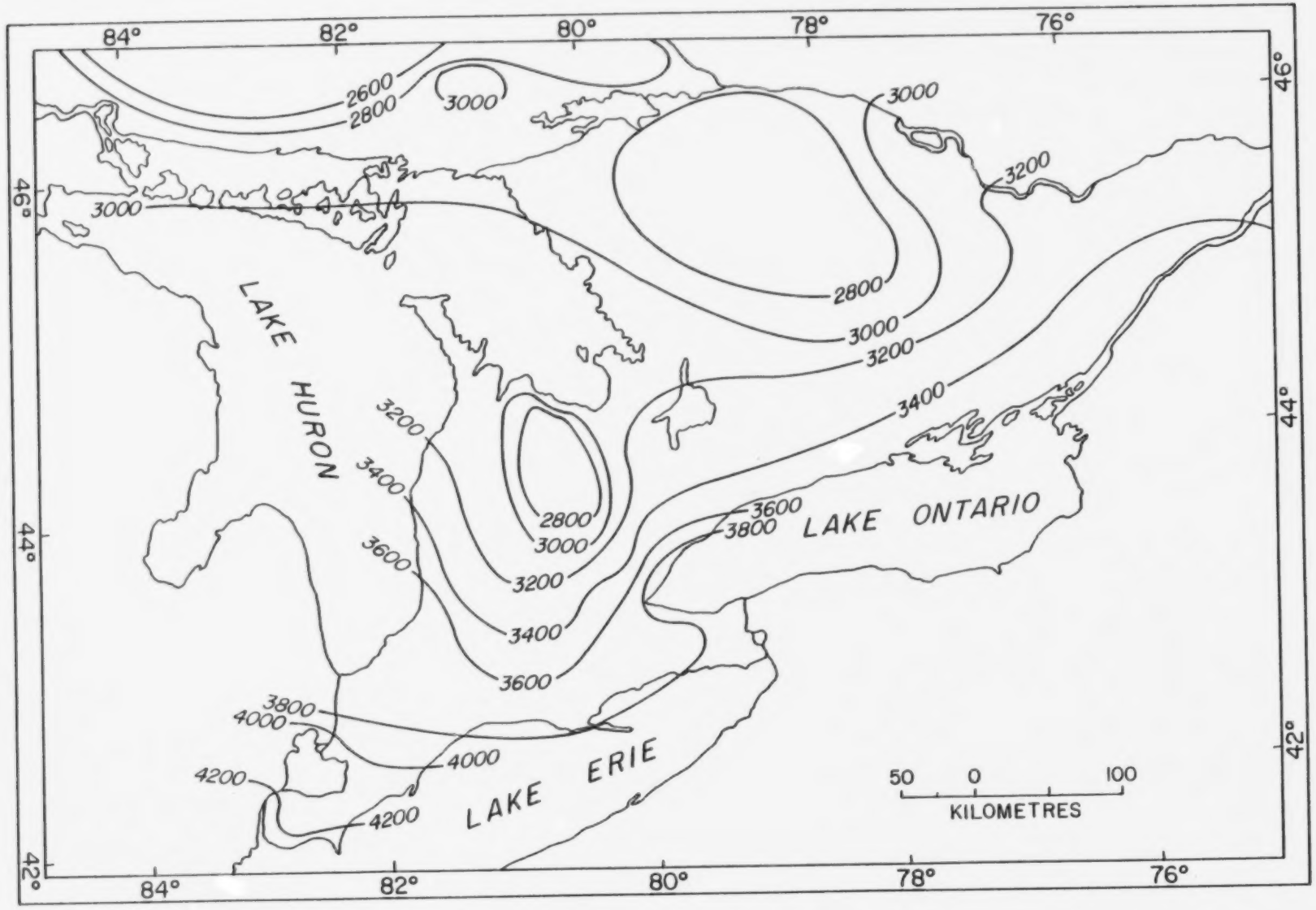

Figure 2 Mean annual growing degree-days of southern Ontario (number of degree-days above 42°F), from Brown et al (1968).

SILVICULTURAL PLANTING KEY

A. Elevation more than 365 m (1200 ft); Growing Degree-Days (GDD) of 3000 or less *(p.12)*

Early fall and late spring frosts frequently occur in most of the swamps of the Southwestern, Central and Eastern Regions at these high elevations.

B. pH of the main rooting zone less than 5 *(p.7)*

C. Heavy underbrush, scrub hardwoods and commercial stands *(p.6)*

D. Flooded for all or most of the growing season (stagnant site) *(p.5)*

E. Not drained *(see next)*

No trees can be established here.

E. Drained

Trees can be established here.

F. Not Mounded *(p.5)*

1. Heavy underbrush

Selected balsam poplar cuttings and northern root-zoned silver maple progenies that are as tall or taller than the underbrush can be shovel, dibble, or auger planted at all elevations up to 460 m (1500 ft). Eastern tamarack, white spruce and white pine can be shovel-planted in the openings. European alder seedlings can be safely planted in all openings up to 396 m (1300 ft). Planting crews become disoriented in heavy underbrush. Rabbit damage may occur on white pine and European alder. Annual release using secateurs will be necessary until the trees grow above the shrubs. Growth will be slow until the trees capture the site.

2. Scrub hardwoods (black ash)

If stand is dense, elongated openings of about 20 m (66 ft) wide and up to 805 m (2640 ft) in length must be prepared by frilling the ash and applying one of the three basal sprays: 2,4,5-T ester, 2,4-D ester or 2-(2,4-DP) to the cull trees in the summer (see Silvicultural Instructions -- Silvicides). Next spring, white spruce, black spruce, white pine and eastern tamarack can be planted. European alder can be safely planted up to 396 m (1300 ft). Herbicides may have to be applied on the sedges, grasses and herbs where necessary. Rabbit damage may occur on white pine. Can expect moderate growth for the first three years.

3. Commercial stands

Do not occur on this site.

F. Mounded

1. Heavy underbrush (shrub willow and red osier dogwood)

White spruce, black spruce, white pine and eastern tamarack can be shovel planted on the mounds. Balsam poplar rootless cuttings can be shovel, dibble or auger planted at all elevations up to 457 m (1500 ft) and European alder can be safely planted up to 396 m (1300 ft). Trees must be released periodically from shrub competition. Rabbit damage may occur on white pine and European alder. Can expect excellent growth and survival within one year of planting.

2. Scrub hardwoods (black ash)

If trees are scattered, the site can be mounded. White spruce, black spruce, white pine and eastern cedar can be successfully shovel planted the following two springs after mounding. Poor planting results can be expected three years after mounding. Balsam poplar rootless cuttings can be planted at all elevations up to 457 m (1500 ft) and European alder can be safely planted up to 396 m (1300 ft). Trees must be released periodically from shrub competition. Rabbit damage may occur on white pine and European alder. Can expect excellent growth and survival within one year of planting.

D. Flooded for part of the growing season only

E. Not drained *(p.6)*

Trees can be established here.

F. Not mounded *(p.6)*

1. Heavy underbrush (shrub willow and red osier dogwood)

Selected balsam poplar cuttings which are as tall or taller than the underbrush can be dibble or auger planted up to 457 m (1500 ft). European alder can be safely planted up to 400 m (1300 ft). Eastern tamarack can be planted in the openings providing there is no overhead shade. Planting crews become disoriented under these conditions. Annual release from overhead competition is imperative for at least the first five years after planting. Can expect only moderate growth until the trees grow above the underbrush.

2. Scrub hardwoods (aspen, balsam poplar, black ash and white birch)

Elongated openings of about 20 m (66 ft) wide and up to 805 m (2640 ft) in length must be prepared by using appropriate silvicides such as 2,4,5-T ester, 2,4-D ester or 2-(2,4-DP) (see Silvicultural Instructions -- Silvicides). Eastern tamarack should be planted the following spring after treatment. Selected balsam poplar rootless cuttings can be dibble or auger planted at all elevations up to 457 m (1500 ft). European alder can be safely planted up to 396 m (1300 ft). Grass and weeds must be controlled with herbicides. Rabbit damage may occur on white pine and European alder. Can expect moderate growth.

3. Commerical stands

This site type is rare in the lowlands of southern Ontario. The main tree components here are black spruce, balsam fir, eastern tamarack and scattered white birch. Sedges, Labrador tea, sphagnum moss and blueberries are the chief plant indicators here. If reforestation is required after logging or wind fall, black spruce and eastern tamarack can be planted on this site. Care should be taken to ensure that the black spruce are planted only on the natural mounds above the high water mark.

F. Mounded

1. Heavy underbrush (shrub willows and red osier dogwood)

White spruce, black spruce, white pine and eastern tamarack can be planted here. Selected balsam poplar rootless cuttings can be dibble or auger planted at all elevations up to 457 m (1500 ft). European alder can be safely planted up to 396 m (1300 ft). Periodic release from underbrush will be necessary. Rabbit damage may occur on white pine and European alder. Can expect excellent growth and survival.

2. Scrub hardwoods (aspen and balsam poplar)

Stand generally too dense for mounding. Treat and plant as in the unmounded scrub hardwood stands.

3. Commercial stands

Cannot be mounded because of stumps and residual trees. Treat as in the unmounded commercial stands.

E. Drained

These sites are not usually drained.

C. Light underbrush

Area mostly covered with grasses, sedges and herbs and in rare instances with an Ericaceae ground cover. Can expect frost damage in the late spring and early fall on sensitive species.

D. Flooded for all or most of the growing season (stagnant site)

E. Not drained *(see next)*

No trees can be established here.

E. Drained

Trees can be established here.

F. Not mounded *(p.7)*

White spruce, black spruce, white pine and eastern tamarack can be hand or machine planted here depending on site conditions. Selected balsam poplar rootless cuttings can be dibble or auger planted up to an elevation of 457 m (1500 ft). European alder can be safely planted up to 396 m (1300 ft). Herbicides must

be applied to the grasses, sedges and herbs until the trees capture the site. Mouse damage may occur on white pine and European alder. Can expect from poor to moderate growth and survival for the first five years.

F. Mounded

White spruce, black spruce, white pine and eastern tamarack should be planted here. Selected balsam poplar cuttings can be dibble or auger planted up to 457 m (1500 ft) elevation. European alder can be safely planted up to 396 m (1300 ft). Competitive herbs and grasses must be controlled with herbicides. Mouse damage may occur on white pine and European alder. Can expect excellent growth and survival within the first year of planting.

D. Flooded for part of the growing season only

E. Not drained

Trees can be established here.

F. Not mounded *(see next)*

Eastern tamarack can be shovel planted. Selected balsam poplar rootless cuttings can be dibble or auger planted up to an elevation of 457 m (1500 ft). European alder can be safely planted up to 396 m (1300 ft). Herbicides must be used to control grasses, sedges and weeds. Can expect only moderate growth for the first five years or until the trees capture the site.

F. Mounded

White spruce, black spruce, white pine and eastern tamarack should be planted here. European alder can be safely planted up to 396 m (1300 ft). May require herbicides to release the trees from grasses and sedges. Rabbit damage may occur on white pine and European alder. Can expect excellent growth and survival.

E. Drained

Rarely drained for economic reasons.

B. pH of the main rooting zone more than 5

C. Heavy underbrush, scrub hardwoods and commercial stands

D. Flooded for all or most of the growing season

E. Not drained *(see next)*

No trees can be established here.

E. Drained

Trees can be established here.

F. Not mounded *(see next)*

1. Heavy underbrush

Northern silver maple progenies and red ash seedlings may be planted in openings in the shrub canopy. Selected eastern cottonwood, European willow and black willow cultivars which are as tall or taller than the underbrush can be shovel, dibble or auger planted providing the elevation is not greater than 396 m (1300 ft). European alder can also be planted up to 396 m (1300 ft) providing the pH is not greater than 7.5. Planting crews become disoriented under these conditions. Can expect slow growth until the trees get above the shrub canopy. Some trees may have to be released using secateurs and axe.

2. Scrub hardwoods (black ash)

Elongated openings of 20 m (66 ft) in width and up to 810 m (2640 ft) in length must be established using 2,4,5-T ester, 2,4-D ester or 2-(2,4-DP) as a basal field spray in the early summer to the black ash if the stand is dense (see Silvicultural Instructions -- Silvicides). Root zoned red ash, of local origin and northern silver maple progeny can be dibble or auger planted. American basswood, white spruce, and white pine can be shovel planted the following spring after the silvicide release of the previous summer. Eastern cottonwood, European willow and European alder selections can be dibble, auger or shovel planted up to an elevation of 396 m (1300 ft). Silver maple, American basswood, red ash and eastern tamarack are specifically recommended for all sites with a pH of 8 or more and European alder on all sites up to a pH of 7.5. Grasses and weeds must be controlled with herbicides. Rabbits and deer may damage white pine, European alder, silver maple and American basswood. Can expect only moderate growth and survival until the trees capture the site.

3. Commercial stands

Do not occur on this site.

F. Mounded

1. Heavy underbrush

Northern silver maple progenies, American basswood, black willow, white spruce, white pine, white cedar and eastern tamarack can be shovel planted here. Hardy eastern cottonwood and European willow cuttings, and root zoned red ash can be dibble or auger planted and European alder can be shovel planted in all elevations up to 396 m (1300 ft). Silver maple, American basswood and red ash are specifically recommended for all sites with a pH of 8 or more and European alder on all sites with a pH up to 7.5. The overhead underbrush must be controlled by pruning until the trees capture the site. Rabbits and deer may damage white

pine, European alder, silver maple and American basswood. Excellent growth and survival can be expected within one year on the wet sand and muck soils and within five years on the wet clays.

D. Flooded for part of the growing season

Trees can be established here.

E. Not drained *(p.10)*

Trees can be established here.

F. Not mounded *(see next)*

1. Heavy underbrush

Root zoned red ash and silver maple northern provenances, hardy eastern cottonwood and European willow cuttings which are as tall or taller than the underbrush can be dibble or auger planted and European alder can be shovel planted in openings in the shrub canopy at all elevations up to 400 m (1300 ft). American basswood, local red ash and eastern tamarack can be planted at all elevations and on all sites with a pH of 8 or more, and European alder on all sites with a pH up to 7.5. The overhead shrubs can be controlled periodically by pruning until the trees get above the underbrush. Rabbits and deer may damage the white pine, silver maple and European alder.

2. Scrub hardwoods (aspen and balsam poplar)

Elongated openings of 20 m (66 ft) in width and up to 805 m (2640 ft) in length must be established by using 2,4,5-T ester, 2,4-D ester or 2-(2,4-DP) as a basal bark spray to the scrub poplar in early summer prior to planting in the following spring (see Silvicultural Instructions -- Silvicides). Root zoned black willow, red ash and silver maple northern provenances can be planted at all elevations whereas eastern cottonwood, European willow and European alder can be safely auger, dibble or shovel planted up to 396 m (1300 ft). Silver maple, American basswood, red ash and eastern tamarack are specifically recommended for all sites with a pH of 8 or more, and European alder on all sites with a pH up to 7.5. Grass and weeds may have to be controlled with herbicides. Rabbits and deer may damage the silver maple and European alder. Can expect only moderate growth.

3. Commercial stands

The main tree components on this site are white spruce, balsam fir, white cedar, white pine, eastern tamarack, balsam poplar, white birch and red maple, After logging, it is recommended that these stands be reforested to red ash and tamarack. White spruce, white pine and American basswood can also be planted on all natural mounds above the high water mark.

F. Mounded

1. Heavy underbrush (shrub willow and red osier dogwood)

Northern silver maple progenies, American basswood, white

spruce, white pine, white cedar, eastern tamarack and black willow can be shovel planted. Selected strains of eastern cottonwood, European willow and European alder can be dibble, auger or shovel planted up to elevations of 396 m (1300 ft); about 3000 GDD. Silver maple, American basswood, local red ash and eastern tamarack are specifically recommended for all sites with a pH of 8 or more and European alder on all sites with a pH up to 7.5. Trees may have to be periodically released from overhead shrub competition. Rabbit and deer damage may occur on white pine, American basswood, silver maple and Europen alder. Can expect excellent growth and survival.

2. Scrub hardwoods (aspen and balsam poplar)

Not possible to mound this site as the stand is generally too dense. (See under F. Not mounded).

3. Commercial stands

Not possible to mound such a stand because of stumps and slash. (See under F. Not mounded).

E. Drained

These sites are not drained for growing trees.

C. Light underbrush

D. Flooded for all or most of the growing season (stagnant site)

E. Not drained *(see next)*

No trees can be established here.

E. Drained

Trees can be established here.

F. Not mounded *(see next)*

White spruce, white pine, white cedar, eastern tamarack, southern silver maple progenies and American basswood can be shovel planted. Hardy selections of Jackii poplar, eastern cottonwood and European willow (plus European alder where the pH is not greater than 7.5) can be dibble or auger planted up to an elevation of 396 m (1300 ft); about 3000 GDD. Silver maple, American basswood, local red ash and eastern tamarack are specifically recommended for all sites with a pH of 8 or more, and European alder on all sites with a pH up to 7.5. Herbicides must be applied when necessary. Mouse damage may occur on American basswood, silver maple and white pine. Can expect from poor to moderate growth for the first five years after planting.

F. Mounded

White spruce, white pine, eastern tamarack, white cedar, northern silver maple progenies, local red ash and American basswood seedlings can be shovel planted here. Balsam poplar and black willow cuttings of from 1.5 to 2.4 m (5-8 ft) can also be planted. Hardy Jackii poplar and eastern cottonwood clones (plus European alder where the pH is not greater than

7.5) can be dibble or auger planted to a depth of 0.6 m (2 ft) up to an elevation of 396 m (1300 ft) -- about 3000 GDD. Silver maple, American basswood, local red ash and eastern tamarack are specifically recommended for all sites with a pH of 8 or more, and European alder on all sites with a pH up to 7.5. Herbicides must be applied until the trees capture the site. Rodent damage may occur on white pine, American basswood and silver maple. Can expect excellent growth and survival on all soils but clay within one year of planting.

D. Flooded for part of the growing season

Trees can be established here.

E. Not drained *(see below)*

Trees can be established here.

F. Not mounded *(see next)*

Root zoned, local red ash, northern silver maple progenies, American basswood, black willow, balsam poplar and eastern tamarack can be planted here. Hardy eastern cottonwood, European willow, silver maple selections can be planted up to an elevation of 396 m (1300 ft); about 3000 GDD. Silver maple, American basswood, red ash and eastern tamarack are specifically recommended for all sites with a pH of 8 or more, and European alder on all sites with a pH up to 7.5. Grasses and sedges must be controlled with herbicides until the trees capture the site. Mouse damage may occur on white pine, silver maple and American basswood. Can expect from poor to moderate growth for the first three years or until the trees capture the site.

F. Mounded

Root zoned local red ash and northern silver maple progenies, balsam poplar and black willow cuttings, American basswood, white spruce, white pine, white cedar and eastern tamarack seedlings can be planted here. Hardy eastern cottonwood (plus European alder where the pH is not greater than 7.5) and European willow selections and progenies can be planted up to an elevation of 396 m (1300 ft) -- about 3000 GDD. Silver maple, American basswood, local red ash and eastern tamarack are specifically recommended for all sites with a pH of 8. Grasses, sedges and herbs must be controlled with herbicides until the trees capture the site. Rodent damage may occur on white pine, American basswood and silver maple. Can expect excellent growth and survival within one year of planting on loam and only moderate growth and survival for the first five years on clay. On clay, all cuttings and root zoned stock should be auger planted to a depth of 0.6 m (2 ft).

E. Drained

Not necessary to drain.

A. Elevation less than 365 m (1200 ft); 3000 GDD or more

Little danger of late spring and early fall frosts in most of the swamps in Southwestern and Central Regions; but frost can be expected in all the saucer-shaped swamps of the Eastern Region which occur more than 48 km (30 miles) north of the St. Lawrence at elevations as low as 91 m (300 ft).

B. pH of the main rooting zone less than 5

C. Heavy underbrush, scrub hardwoods and commercial stands

D. Flooded for all or most of the growing season (stagnant swamp)

E. Not drained *(see next)*

No trees can be established here.

E. Drained

Trees can be established here.

F. Not mounded *(see next)*

1. Dense underbrush with scattered black ash.

Selections of balsam poplar and silver maple root zoned cuttings or seedlings which are as tall or taller than the underbrush can be shovel, dibble or auger planted here. European alder, white spruce, white pine and eastern tamarack can be planted in all openings. Planters become disoriented on this site. Periodic release using secateurs and axe will be necessary. Rabbit and deer damage may occur on silver maple, white pine and European alder. Growth will be slow until the trees grow above the underbrush.

2. Scrub hardwoods (scattered black ash)

Sites are almost identical to the dense underbrush sites and must be treated similarly.

3. Commercial stands

Do not occur here.

F. Mounded

1. Dense underbrush with scattered black ash.

Same species can be planted here as on the unmounded sites. However, the trees will grow faster, more trees can be planted, and the planters will not be disoriented.

2. Scrub hardwoods

Same results as in the mounded, dense underbrush sites.

D. Flooded for part of the growing season only

E. Not drained *(p.14)*

Trees can be established here.

F. Not mounded *(see next)*

1. Heavy underbrush (shrub willow and red osier dogwood)

Selections of balsam poplar, silver maple, European alder and eastern tamarack can be shovel, dibble or auger planted on this site, depending on whether they are cuttings, root zoned stock or seedlings. Planting crews become disoriented under these conditions. Periodic release using secateurs and axe will be necessary. Rabbit and deer damage may occur on silver maple and European alder. Growth will be slow until the trees grow above the shrubs.

2. Scrub hardwoods (aspen and balsam poplar)

Elongated openings of 20 m (66 ft) wide and up to 805 m (2640 ft) long must be prepared by applying 2,4,5-T ester, 2,4-D ester or 2-(2,4-DP) as a basal bark spray to the scrub poplars (see Silvicultural Instructions -- Silvicides). European alder, balsam poplar, silver maple and eastern tamarack selections can be shovel, dibble or auger planted depending on whether they are seedlings, root zoned stock or cuttings, or whether the soil is a loam or a heavy clay. Mouse and rabbit damage may occur on silver maple and European alder. The sedges, grasses and herbs may have to be controlled with an effective herbicide. Can expect excellent growth for European alder, only moderate growth for balsam poplar, silver maple and eastern tamarack for at least five years.

3. Commercial stands

A mixture of black spruce, white spruce, balsam fir, white pine, eastern tamarack and white birch comprises the original stand. If such a stand is logged, white spruce, white pine and eastern tamarack should be planted on all natural mounds above the high water mark. Can expect moderate growth for the first five years after planting.

F. Mounded

1. Heavy underbrush (shrub willow and red osier dogwood)

Selections of balsam poplar cuttings and root zoned silver maple seedlings that are as tall or taller than the underbrush can be shovel, dibble or auger planted. European alder, white spruce, white pine and eastern tamarack seedlings must be shovel planted. Rabbit and deer damage may occur on silver maple, white pine and European alder. Trees will have to be periodically released with secateurs and axe from shrub competitors. Can expect excellent growth within one year of planting.

2. Scrub hardwoods (aspen and balsam poplar)

Stands are generally too dense to mound. (See under F. Not mounded).

3. Commercial stands (after logging)

Stumps and trees are too dense to mound. (See under F. Not mounded)

E. Drained

Not necessary to drain this site - so plant as indicated in F.

F. Not mounded for heavy underbrush, scrub hardwoods and commercial stands. *(see next)*

F. Mounded - not necessary

C. Light underbrush

Site consists mainly of grasses, sedges and herbs.

D. Flooded for all or most of the growing season (stagnant site)

E. Not drained *(see next)*

No trees can be established here.

E. Drained

Trees can be established here.

F. Not mounded *(see next)*

Selections of balsam poplar cuttings and root zoned silver maple seedlings can be shovel, dibble or auger planted. European alder. white pine and eastern tamarack can be shovel planted here. European willow will capture this site within five years without release. The other hardwoods and conifers will require release using herbicides. Mouse damage may occur on white pine and silver maple. Can expect slow growth for the first five years.

F. Mounded

Selections of balsam poplar, silver maple, European alder, white spruce, white pine and eastern tamarack can be shovel, dibble or auger planted depending on whether they are rooted or rootless stock. Herbicides must be applied to control grasses and herbs. Mouse damage may occur in white pine and silver maple. Can expect excellent growth for all species within one year of planting.

D. Flooded for part of the growing season only

Trees can be established here.

E. Not drained *(p.15)*

Trees can be established here.

F. Not mounded *(p.15)*

Plant same species as recommended for the drained, not mounded sites previously described.

F. Mounded

Plant the same species as recommended for the drained, mounded sites previously described. Will get the same excellent results.

E. Drained

Not necessary to drain.

B. pH of the main rooting zone greater than 5

C. Heavy underbrush, scrub hardwoods and commercial stands

D. Flooded for all or most of the growing season (stagnant site)

E. Not drained *(see next)*

No trees can be established here.

E. Drained

Trees can be established here.

F. Not mounded *(p.16)*

1. Dense underbrush

Selections of silver maple, red ash, eastern cottonwood, black willow, European willow cuttings, American basswood and European alder root zoned seedlings can be shovel, dibble or auger planted in openings or providing they are as tall or taller than the surrounding underbrush. Eastern cottonwood does best at elevations less than 305 m (1000 ft) (with more than 3500 GDD) in the Southwestern and Central Regions. Silver maple, American basswood, local red ash and eastern tamarack are specifically recommended for all sites with a pH of 8 or more and European alder on all sites with a pH up to 7.5. Rabbit and deer damage may occur on silver maple, eastern cottonwood, American basswood, European willow and European alder. Trees must be released at periodic intervals with secateurs and axe until they get above the underbrush. Planting crews become disoriented under these conditions. Can expect excellent growth within the same year as planted.

2. Scrub hardwoods (black ash)

Elongated openings of 20 m (66 ft) wide and up to 805 m (2640 ft) in length must be prepared by applying 2,4,5-T ester, 2,4-D ester or 2-(2,4-DP) as a basal frill spray to the ash. Selections of root zoned silver maple and red ash seedlings, eastern cottonwood, black willow and European willow cuttings as well as European alder, American basswood, white spruce, white pine and eastern tamarack seedlings can be planted here. Silver maple, American basswood, local red ash and eastern tamarack are specifically recommended for all sites with a pH of 8 or more, and European alder on all sites with a pH up to 7.5. Grasses and weeds must be controlled with herbicides. Rabbit, mouse and deer damage may occur on silver maple, European alder, European willow, eastern cottonwood, American

basswood and white pine. All species will grow well within three years of planting.

3. Commercial stands do not occur on this site.

F. Mounded

1. Dense underbrush

Root-zoned silver maple, red ash seedlings, Jackii poplar, eastern cottonwood, black willow and European willow cuttings can be auger or dibble planted and European alder, American basswood, white spruce, white pine, white cedar and eastern tamarack seedlings can be shovel planted here. Eastern cottonwood does best at all elevations less than 305 m (1000 ft) with more than 3500 GDD in the Southwestern and Central Regions. Silver maple, American basswood, local red ash and eastern tamarack are specifically recommended for all sites with a pH of 8 or more, and European alder on all sites with a pH up to 7.5. All mounds will regenerate to silver maple, eastern cottonwood, European alder and red ash if seed trees are in the vicinity. Planted trees must be periodically released with secateurs and axe. Rabbit and deer damage may occur on silver maple, eastern cottonwood, European willow, American cottonwood and white pine. All species will grow well within one year of establishment. Auger planting to a depth of 0.6 m (2 ft) is recommended for all cottonwood cuttings and root zoned seedlings on the clay soils, but is not recommended for root zoned silver maple or red ash.

2. Scrub hardwoods

Stands are too dense to mound (See under F. Not mounded)

D. Flooded for part of the growing season

E. Not drained *(p.18)*

Trees can be established here.

F. Not mounded

1. Heavy underbrush

Root zoned silver maple, and red ash seedlings and Jackii poplar, eastern cottonwood cuttings and American basswood seedlings, European willow and black willow can be shovel, dibble and auger planted providing they are planted in openings and/or providing they are as tall or taller than the surrounding underbrush. Eastern cottonwood can be planted at all elevations up to 305 m (1000 ft) with more than 3500 GDD in the Southwestern and Central Regions. Silver maple, American basswood, local red ash and eastern tamarack are specifically recommended for all sites with a pH of 8 or more, and European alder for all sites with a pH up to 7.5. Rabbit and deer damage may occur on silver maple, eastern cottonwood, American basswood and European willow. Trees must be periodically released using secateurs and axe. Can expect excellent growth within three years after planting.

2. Scrub hardwoods (aspen and balsam poplar)

Elongated openings of approximately 20 m (66 ft) wide and up to 805 m (2640 ft) in length must be prepared by applying either 2,4,5-T ester, 2,4-D ester or 2-(2,4-DP) as a basal bark spray to the cull poplar (See Silvicultural Instructions -- Silvicides). Root zoned silver maple and red ash seedlings, eastern cottonwood, Jackii poplar, European and black willow cuttings and European alder and American basswood seedlings can be shovel, dibble or auger planted here depending on whether they are seedlings, cuttings or root zoned stock. Silver maple, American basswood, local red ash and eastern tamarack are specifically recommended for planting on all sites with a pH of 8 or more, and European alder for all sites with a pH up to 7.5. Rabbit, mouse and deer damage may occur on silver maple, eastern cottonwood, American basswood and European alder. Herbicides must be applied periodically to the ground vegetation when necessary. Can expect excellent growth and survival within three years of planting.

3. Commercial stands

These stands occur on the most productive swamp sites in southern Ontario. They consist of pure stands of silver maple, eastern cottonwood, balsam poplar and red ash, or as a mixture of these four species along with scattered specimens of bur oak, American basswood, trembling aspen, eastern tamarack, peach leaf and black willow and Jackii poplar. Most of the stands are clear cut, while a few are selectively logged. Regardless of the logging method, they generally reproduce to the original composition. Planting is only recommended in fail areas. Eastern cottonwood should be planted on all elevations below 305 m (1000 ft) - 3500 GDD or more. Progenies of silver maple and red ash from superior populations should also be introduced wherever possible. Each of the following commercial stands should be managed if only to ensure adequate stocking of the preferred species.

(a) Silver maple stands

Of all the tree species growing in the swamps at an elevation less than 366 m (1200 ft) with 3000 GDD or more and with a pH greater than 5, silver maple appears to be best suited to this site, as it will regenerate readily by coppicing from freshly cut stumps as well as from seed. To increase the seedling composition over the coppice, it is recommended that the stand be given a pre-harvest cut five years before clear cutting to release the suppressed seedlings of silver maple, red ash and American elm. These three tree species will regenerate heavily each year but will usually only survive for one or two years under dense shade. In all fail areas, after logging, selections of silver maple, eastern cottonwood, European willow and European alder can be planted.

(b) American elm stands

The American elm swamps, which have been devastated by the Dutch elm disease since 1965, should be reforested before the undesirable shrub and herb species take control of the site. It is recommended that silver maple, eastern cottonwood, red ash, European willow and European alder

selections from good populations be planted on all natural mounds in all openings. Any eastern cottonwood plantings should be confined to all elevations less than 305 m (1000 ft) with more than 3500 GDD, and European alder to all sites with a pH up to 7.5.

(c) Eastern cottonwood stands

Eastern cottonwood occurs in almost pure stands with scattered silver maple, red ash and black willow, or as isolates in a mixture of these three species. In either case, silver maple and red ash regeneration predominate on these sites. Mature stands of cottonwood should be clear cut in the fall before flooding, or after the swamp has frozen over. The following summer or fall, after logging, when the site has dried, the slash should be bulldozed into windrows and burnt. If this is not feasible, then lopping and scattering of the slash is advised. Such steps are taken to release the silver maple and red ash regeneration already present, as well as to establish cleared areas for introducing selected clones and progeny of eastern cottonwood. In lightly stocked stands, where seed trees are available, slash clearing in conjunction with soil scarification is recommended to stimulate natural regeneration of this species.

(d) Balsam poplar stands

This species frequently occurs in almost pure stands. When mature, these stands are often selectively logged for timber, leaving openings of 0.2 ha (0.5 acres) or larger. The clearings can be selectively planted within two years of logging to European alder, eastern cottonwood, red ash, American basswood, white spruce and white pine. Eastern cottonwood can be planted safely up to 305 m (1000 ft); 3500 GDD or more. Silver maple and American basswood are specifically recommended for all these sites with a pH of 8 or more and European alder for all sites with a pH up to 7.5.

(e) Red ash stands

This species generally occurs in mixtures with silver maple, eastern cottonwood and balsam poplar. However, it sometimes occurs in almost pure stands. As these stands approach maturity they are generally well stocked to red ash and silver maple seedlings. The seedlings will be released following logging. All fail areas can be reforested with eastern cottonwood, silver maple, red ash and European alder progeny and clones of the aforementioned species from good populations.

E. Drained

Not economical or necessary to drain.

C. Light or no underbrush

Areas mainly covered with grasses, sedges and herbs.

D. Flooded for all or most of the growing season (stagnant site)

E. Not drained *(see next)*

No trees can be established here.

E. Drained

Trees can be established here.

F. Not mounded *(see next)*

Selections of silver maple, eastern cottonwood, black willow and European willow root zoned cuttings or seedlings can be dibble or auger planted here. Seedlings of European alder, American basswood, eastern tamarack, white spruce, white cedar and white pine can also be shovel planted here. Silver maple, American basswood, local red ash and eastern tamarack are specifically recommended for such sites if the pH is 8 or more and European alder on all sites with a pH up to 7.5. All trees with the exception of European alder may require some chemical release from grasses, sedges and herbs. Mouse damage may occur on silver maple, eastern cottonwood, American basswood, European willow and white pine. Most of the trees should grow well on this site within three years of planting.

F. Mounded

The same species can be planted here as on unmounded sites. However, the trees will become established faster and require less post-planting care. Mouse damage will occur on the same species as on the unmounded sites.

D. Flooded for part of the growing season

E. Not drained *(p.20)*

Trees can be established here.

F. Not mounded *(p.20)*

Silver maple, eastern cottonwood, black willow and European willow, red ash, American basswood and European alder can be shovel, dibble or auger planted on this site. Eastern cottonwood does best at elevations less than 305 m (1000 ft), 3500 GDD or more in the southwestern and central regions. Silver maple, American basswood, local red ash and eastern tamarack are specifically recommended for these sites if the pH is 8 or more and European alder for all sites with a pH up to 7.5. Trees, with the exception of the European alder, must be periodically released from grass, sedge and herb competition. Mouse and deer damage may occur on silver maple, eastern cottonwood, American basswood and European willow. Can expect excellent growth within three years of planting.

F. Mounded

Silver maple, eastern cottonwood, black willow, European willow, red ash, American basswood and European alder can be shovel, dibble or auger planted on this site, depending on whether they are seedlings or cuttings. In addition, white spruce, white pine and eastern tamarack can also be planted. Silver maple, American basswood, local red ash and eastern tamarack are specifically recommended where the pH is 8 or more and European alder for all sites with a pH up to 7.5. Mouse and deer damage may occur on silver maple, American basswood, European willow and white pine. Very little herbicide release will be necessary as the trees wil quickly capture the site.

E. Drained

Not economical to drain.

Silver Maple

This species is mostly confined to the swamps of southern Ontario where it occurs in pure stands or in a mixture with American elm, eastern cottonwood, red ash and black willow. The best stands of silver maple are found at elevations of less than 346 m (1200 ft), growing in calcareous soils with a pH of approximately 7. The main indicator plants in order of importance are jewel weed, slender nettle, poison ivy, sensitive fern, and cardinal flower. However, in cutover stands which have not regenerated to trees, good silver maple sites may be identified by the presence of jewel weed, Joe pye weed, swamp milkweed and sedges. Southern strains can be successfully planted up to 366 m (1200 ft), above this elevation northern strains can be safely planted up to 460 m (1500 ft).

Silver maple seedlings can be easily established on muck, wet sands and silt loams with little tending other than release when required from overhead shrub competition. However, on poorly drained clays supporting red osier dogwood, it is recommended that the area be mounded in late summer and then interplanted the following spring to an alternating mixture of silver maple and European alder at a 2.4 m (8 ft) spacing between or within rows.

Cutover stands of silver maple can be readily reproduced by seed, coppice from fresh stumps and by planting.

This species, though much maligned by some foresters, has a great potential for timber and pulp production in most of the swamps and bottomlands of southern Ontario. Much of this criticism may be attributed to the overall appearance of unmanaged even-aged stands which have never been thinned to improve growth and the quality of the crop trees. However, experimental thinning studies in 1953 in the Beverly swamp and a 1966 thinning in the Greenock swamp revealed the growth potential of this species. For instance one 40-year-old stand in the Beverly swamp had a total of 906 m^3 per hectare (100 cords per acre).

Good populations of straight and wavy grained timber trees occur in Burford, Beverly and Greenock townships. Some swamp selections have also been located in natural stands that have a sugar content greater than 3%.

Jackii Poplar

Jackii poplar is a hybrid between an eastern cottonwood mother and a balsam poplar father. The hybrid generally occurs as isolates in silver maple, eastern cottonwood and balsam poplar stands. Most of the selections that have been located to date are fast growing, of good form and of high quality. They have the advantage of being not only hardier and with a greater range than eastern cottonwood, but most are not attacked by mice, rabbits or deer, as are cottonwoods. Unfortunately they are susceptible to borers and canker. This species can be readily reproduced by cuttings and by seed from controlled crosses. Cultivars of the better phenotypes could be made available through the District Offices of the Ontario Ministry of Natural Resources.

Eastern Cottonwood

The natural habitat and range of this species is in the calcareous swamps which occur in a 16 to 48 km (10 to 30 mile) band along the north shore of Lake Erie and Lake Ontario, as well as east of Lake Huron. It can be planted as rooted, root zoned or rootless cuttings on most elevations less than 306 m (1000 ft) in the Southwestern Region and the western half of the Central Region. On clays with a pH up to 7.5 interplant this species with European alder which will also serve as an excellent nurse crop tree. This species is particularly susceptible to rodent and deer injury. Cultivars and progeny of eastern cottonwood could be made available through the District Offices of the Ontario Ministry of Natural Resources.

Balsam Poplar

This adaptable species is found in southern Ontario on both basic and acid soils at all elevations up to 518 m (1700 ft). The chief indicator plants of this species where it is dominant are sedges, red osier dogwood and dwarf willow. It is very common throughout parts of the Greenock, Luther and Puslinch swamps. Root zoned or rootless cuttings from 1.5 to 2.4 m (5 to 8 ft) high should be planted only when recommended. They are never recommended on heavy clays.

Red Ash (also referred to as green ash)

Red ash is found in most of the swamps of southern Ontario. The best populations in Ontario occur in the Burford, Greenock and Beverly swamps. It occurs pure in small stands, or in mixtures of various intensities, with silver maple, eastern cottonwood and balsam poplar. Plant indicators of good silver maple and eastern cottonwood sites are also the same indicators for good red ash sites.

It is recommended that red ash be alternately planted with European alder at a 2.4 (8 ft) spacing on all imperfectly drained mineral soils with a pH not exceeding 7.5, at 370 m (1200 ft) elevation or less. The alder will not only supply nitrogen to the ash but will eliminate competitive grasses and weeds as well as offer side protection to the developing stand. Red ash can be readily planted as 0.3 - 0.6 m (1-2 ft) high seedlings or as 1.5 - 2.4 m (5-8 ft) high root zoned seedlings. The latter size provides considerable competitive advantage on sites covered with shrub growth.

This is an extremely valuable swamp species, and should be incorporated into every swamp and bottomland reforestation program. Since 1958, 14 plus trees have been located in the three aforementioned swamps, and most of these have been grafted onto red ash grafting stock at Maple. Two red ash seed orchards have been established in 1980 at Glencairn and Elderslie. However, they will not meet the seed requirements of the Ministry for at least 10 years. If high quality seedlings are required before that time, wildings can be picked up from high quality stands.

European Alder

Preliminary studies have indicated that European alder will grow well at a pH of 7 or less but very slowly at a pH of 8. It does best on moist to wet, well drained to poorly drained mineral and shallow muck soils on bottomland sites up to an elevation of 400 m (1300 ft). Above this elevation, dieback from early fall and late spring frosts frequently occurs. This species is a heavy producer of nitrogen-fixing bacteria which are found in nodules on the roots. It is recommended that alder be interplanted at a 2.4 m (8 ft) spacing either between or within rows with Jackii poplar, eastern cottonwood, European willow, red ash and silver maple as a source of nitrogen and timber, and to eliminate grass and weed competition which

is common on such sites. Weed control by European alder is essential on the clay flats where this species will regenerate rapidly, capturing the entire site within 10 years of establishment.

European Willow

This species will grow within the natural range of eastern cottonwood. Unfortunately, it is a favourite food for rabbits and mice. Planting should be confined to elevations less than 370 m (1200 ft), the area baited for mice, and hunting encouraged for rabbits and hares.

It is recommended that on all wet muck and mineral soils this species be interplanted with European alder at a 2.4 m (8 ft) spacing. The alder will supply nitrogen and at the same time will eliminate competitive grasses and weeds as well as offer side protection to the young willow. The willow should be planted in early spring as 2.4 - 3.7 m(8-12 ft) long rootless cuttings to a depth of at least 0.6 m (2 ft). Such cuttings can be readily dibble planted in muck and sands and auger planted in silts and clays. Cuttings of superior clones can be made available through the District Offices of the Ontario Ministry of Natural Resources.

White Spruce

This species can be successfully planted on all mounded areas with no initial "check" to their growth. However, if planted in a beaver meadow, herbicides should be applied each year to control the sedges and grasses until the trees have captured the site. There appear to be acid-loving strains, which occur in the Precambrian Shield, and alkaline-loving strains, which occur on the calcareous soils of southern Ontario. Therefore, it would be wise to obtain the seedlings from a good seed source as close to the planting area as possible. Seedlings can be purchased from the Ontario Ministry of Natural Resources.

Black Spruce

This species is only recommended for planting in southern Ontario on acid soils covered with such Ericaceae ground cover and associates as Labrador tea, blueberry, huckleberry and sphagnum moss. Even under these conditions in southern Ontario the black spruce, which does occur naturally on the aforementioned site, is no faster growing here than farther north. However, all other tree species grow poorly under these conditions in southern Ontario. Small stands occur in the needle swamps north of Guelph, in portions of the Ellice swamp and in the pocket swamps along the north shore of Lake Ontario.

White Pine

In Ontario, white pine occurs in both swamp and upland sites. It is not known whether there are lowland and upland strains or acid-loving and alkaline-loving strains. For this reason, it is recommended that the seedlings for each planting area come from a good population which grows as close to the planting site as possible.

White pine is suited to most of the imperfectly drained mineral soils in the lowlands of this Province. It does particularly well on the heavy clays after a slow start from 5 to 8 years. This establishment time could be reduced if it was interplanted with European alder at 2.4 m (8 ft) spacing within or between rows. Alder will not only supply nitrogen but will quickly eliminate competitive weeds and grasses. Seedlings can be purchased from the Ontario Ministry of Natural Resources.

Eastern Tamarack

Eastern tamarack is making a comeback in both southern and northern Ontario from the severe devastation of the larch sawfly that wiped out most of the tamarack stands between 1906-1926. It is an extremely hardy species and has a wide pH tolerance (from about 4.0 to 8.0). There are good populations in the Puslinch and Greenock swamps. Here, there are timber trees thatare growing on soil with a pH of from 5 to 8. This species also occurs in the Luther marsh, but the stands are of low quality which may be attributed to the semi-stagnant conditions, induced by extremely poor drainage, in the heavy clay soils of that region. It is possible that by ditching and by mounding improved growing conditions could be created in the Luther marsh complex for this potential valuable swamp species.

Seeds should be collected from good stands on the calcareous soils of southern Ontario for future planting in this part of the Province. This species does well on all imperfectly drained mineral soils. It is particularly recommended for the poorly drained heavy clays on lowland sites. Although it is not necessary, this species could be interplanted on all sites below 370 m (1200 ft) elevation with alder at a 3.7 m (12 ft) spacing within or between rows as an alternative crop, in case the tamarack are again devastated by the larch sawfly.

Animal Repellents

There are a number of different animal repellents that have been used for many years. For instance, German foresters are reputed to have smeared fresh cow dung on the succulent growth of young hardwoods to repel deer. Today Thiram, with different adhesives, is the common animal repellent, being effective during the winter against mice, rabbits and deer. This chemical, which is a sticky white liquid, is applied to a band around the base of the trunk with a paint brush, ensuring that the bark is coated with the repellent to prevent partial or complete girdling of the tree.

Herbicides

There are many herbicides on the market today for use in controlling grasses, sedges and broad-leaved weeds. Three of the most effective in reforestation are water soluble, namely: Simazine, Gramoxone and Glyphosate. Each is usually applied separately for specific reasons. Simazine is a preemergent herbicide and is applied at the rate of 28.4 g (1 oz) in 4.546 L (1 gallon) of water in the spring before growth starts, or in the fall after growth has ceased. Gramoxone is a contact herbicide which destroys the chlorophyll of the leaves giving a "burnt-off" effect. It is applied separately or with Simazine during the growing season at the rate of 5.68 mL (2 fl oz) in 4.546 L (1 gallon) of water. Glyphosate is a migratory chemical which penetrates the leaf and migrates to the roots. It is applied during the growing season in a 1.8 m (6 ft) diameter circle around the base of each tree at the rate of 3.0 mL (1.2 fl oz) in 4.546 L (1 gallon) of water. This herbicide is most effective if mixed with Simazine.

Rodenticides

Rodenticides are chemical compounds used to kill mice and rabbits. For mouse control, strychnine-treated seed, or phosphide pellets may be used in the field. To prevent birds from being poisoned by the bait, the seed or pellets are placed in used quart-sized oil cans or in upright, capped, U-shaped aluminum pipes made for the purpose. These are spaced about 12 m (40 ft) apart. The poison stations should be positioned in the field not later than the end of August. For rabbit control, intensive hunting is recommended and if this is unsatisfactory, strychnine-baited apples and aspen branches may be placed in the area. The plantation should be patrolled every morning to remove the dead animals and prevent their consumption by predatory birds or animals.

The snowshoe hare, the cottontail rabbit and the meadow mouse will girdle silver maple and eastern cottonwood. American basswood is often severely browsed by rabbits. European alder is a source of food for snowshoe hares only. Deer will browse silver maple and cottonwood.

Silvicides

The silvicides 2,4,5-T ester, 2,4 -D ester and 2-(2,4-DP) are effective when applied as a basal spray to the trunk of the trees to be eliminated. Recently, 2,4,5-T ester has been banned by the Government of Ontario but there is some indication that it might be back in forestry use in the near future. Each of these three chemicals are effective against silver maple, trembling aspen and balsam poplar when applied with a paint brush as a

basal bark spray to approximately a 30 cm (12 in) wide band directly around the basal circumference of the tree. Other trees like black ash must be frilled with an axe to which one of the aforementioned silvicides is applied.

For best results, all three chemicals should be applied in late winter, spring and early summer. The silvicide 2,4,5-T ester should be prepared by mixing 17.0 mL (6 fl oz) of the concentrate to 4.6 L (1 gal) of fuel oil. The other two silvicides can be prepared by mixing 22.4 mL (8 fl oz) of the concentrate to 4.61 (1 gal) of fuel oil.

Application of silvicides as a basal or foliage spray to shrubs is not recommended for releasing planted trees because of difficulties in application and waste of the chemical. Instead, secateurs and axe are all that are required to remove overhead competition. In fact the presence of shrubs surrounding a tree appears to protect it from exposure. This is often indicated by faster growth of the planted trees where shrub cover such as scrub willow is present as opposed to trees of the same species in open grassy areas on the same site. The slower growth in the open areas may be attributed to exposure and to the presence of competitive grasses and sedges.

Drainage

Drainage is recommended for all stagnant sites, as well as for those semi-stagnant sites where mounding might be difficult. Suitable drainage can be established using a 17-ton hydraulic back-hoe, a drag line or with ditching dynamite. The hydraulic back-hoe and the drag line do a cleaner job than does the ditching dynamite. Costs for all three methods were competitive in 1970, but with rising fuel costs in the 1980's, ditching dynamite is probably now less expensive.

If an area is to be drained, it is recommended that a picket line be established along the lowest contours in the early spring as indicated by water movement to assure maximum drainage of the area. It is also advised that the tall trees be cut on the picket line so that the excavating machine is not slowed down, or if dynamite is used, the trees do not interfere with blasting.

Mounding

This operation is done by a tractor and mounding plow in late summer or early fall so that the mounds will settle during the ensuing winter permitting planting the following spring. Mounding consists of turning over a furrow about 38 cm (15 in) deep with a mould-board designed specifically for this purpose, thus creating a continuous "mound" of exposed soil approximately 38 cm (15 in) high which, when turned over, superimposes the O, A and B soil horizons of the mound directly on top of the O and A horizons of the underlying undisturbed soil. By following a plan, mounded rows of a predetermined spacing can be established throughout the planting area. This action not only induces aeration and drainage, but creates a nutrient layer between the two O and A layers. It is here that the roots of the planted trees will obtain extra nutrients during their initial establishment. Planting should be done within two growing seasons after mounding. This is particularly important on the beaver meadow sites and in the dense underbrush covered sites where the grasses, sedges and shrubs will have regained their competitive advantage after that time.

Experimental data from plantations established on a wide range of swamp and bottomland sites have indicated that mounding is not always necessary. However, it is recommended on all semi-stagnant sites that have not been drained. For the best results when mounding in such swamps, it is imperative that the mounds should run at right angles to the contours to ensure maximum drainage. However, for those swamps that are only flooded for a part of the growing season, mounds should be established, if possible, at right angles to the drainage system so that water is held in situ during the dry season. This is particularly important on clay soils which tend to dry out in the summer. Mounding is also advised on sites supporting dense underbrush not exceeding 2.4 m (8 ft) in height and in beaver meadow swamps. In both instances, the trees should be planted within two years of mounding, otherwise the swamp vegetation will become re-established by the third year and offer severe competition to the planted trees. Mounding creates an ideal planting medium for the trees by aerating the soil, improving the drainage, increasing the fertility, and reducing root and overhead competition. It also permits the area to be uniformly planted, as well as keeping the planters properly oriented at all times.

If mounding is recommended, it is absolutely essential that the proper type of plow be used and not the type commonly used in agriculture. The latter produces too shallow a mound, which creates an extremely difficult planting zone, as the shallow overturned root zone of the furrow is superimposed directly onto the undisturbed root zone adjoining the furrow with little or no loose soil on top of the mound. This double root zone makes it extremely difficult to penetrate with a shovel when planting on many lowland sites.

Planting Seedlings and Cuttings

Hand planting may be done with a shovel, dibble or a portable motorized soil auger depending on whether the trees are conifers or hardwoods, seedlings or cuttings, and whether the soil is a loam or heavy clay. Generally, all seedlings and conifers are shovel planted, whereas all root zoned seedlings and rootless cuttings are dibble or auger planted. Shovel planting consists of preparing a slit, wedge or hole to accommodate the root system. In loose textured soils on the lowland sites the roots can be severely pruned as such soils are constantly moist to wet during the spring planting season. If the lateral roots are completely removed leaving only the root zone the trees can be dibble or auger planted. Dibble planting consists of making a cylindrical hole 0.6 m (2 ft) deep and about 5 cm (2 in) wide with 1.2-1.5 m long wooden rod, inserting a cutting and then firmly stamping the soil around the stem of the planted stock. A shovel handle makes an ideal dibble for sand, silt and muck soils but will not penetrate a clay soil to the desired depth. For clay soils, a portable mechanized soil auger is required to reach the required depth of 0.6 m (2 ft). This planting depth is essential to insure that the planted cuttings will receive adequate moisture during dry periods in the growing season. Shallow planting on such sites results in stunted trees and heavy mortality.

Machine planting is only recommended on open, drained, unmounded sites with a light ground cover, that are to be planted to conifers and hardwoods which do not exceed 0.6 m (2 ft) in height. Generally, most of the swamps must be hand planted due not only to the heavy ground cover and underbrush but also to the softness of the soil in the spring, a condition which will not support heavy equipment.

Soil Sampling

Soil sampling consists of digging or augering a hole down to parent material in several randomly selected locations within the site. This permits each soil horizon to be physically evaluated as to colour, texture, drainage, etc. At the same time a composite sample is taken of the main rooting zone which may be tested for pH. These readings are considered important and are an integral part of the planting key.

Spacing

This is one of the most important factors to consider when establishing a plantation under lowland conditions. The decision made on spacing, at the time of planting, will affect the number of trees per hectare, planting costs, how soon the trees will capture the site, rate of diameter and height growth, crown size, tree form, stand density and timber quality. Before any meaningful spacing interval is settled on tree species, site conditions, costs of planting, pruning and releasing should be considered. For instance, on those sites where one might expect considerable mortality, conifers should be spaced at 1.8 x 2.4 m (6 x 8 ft) providing 2243 trees per hectare (908 trees per acre), and hardwoods at 3.7 x 2.4 m (12 x 8 ft), providing 1120 trees per hectare (455 trees per acre). As a general rule, where little mortality is expected, conifers should be spaced at 2.4 x 2.4 m (8 x 8 ft), providing 1680 trees per hectare (680 trees per acre) and hardwoods at 3.7 x 3.7 m (12 x 12 ft), providing 746 trees per hectare (302 trees per acre).

However, if blocks of conifers and hardwoods are to be planted within the same area and little mortality is expected, then all rows should be spaced 2.4 m (8 ft) apart so that the conifers can be planted at 2.4 x 2.4 m (8 x 8 ft) and the hardwoods at 4.9 x 2.4 m (16 x 8 ft), providing 840 trees per hectare (340 trees per acre). The width between each mounded row can be easily estimated by the tractor driver using the blade of the tractor as a measure, while the spacing between the trees in each row can be paced off by the planters.

GLOSSARY

Acid soil - A soil that has a pH of less than 7, whose aqueous solution will turn blue litmus paper red and react with bases to form salts.

Alkaline soil - A soil that has a pH greater than 7 and whose aqueous solution will turn red litmus paper blue.

Allelopathy - The influence of plants other than micro-organisms upon each other, arising from the products of their metabolism.

Animal pests - The snowshoe hare, cottontail rabbit and meadow mice will girdle silver maple and eastern cottonwoods. American basswood is often severely browsed by hares and rabbits. Deer will browse silver maple and eastern cottonwood saplings. European alder is not a source of food for cottontail rabbits, mice or deer, but it is browsed by snowshoe hares. All the aforementioned trees must be protected in the sapling stage by rodenticides and repellents.

Animal repellent - A chemical compound applied to or around plants to repel animals from feeding on the plant or from inflicting chemical or physical injury on some part of the tree.

Auger - A hand or mechanized boring tool consisting of a shank with spiral channels used to make a planting hole into which the stem of a tree or shrub is inserted to the required planting depth.

Basal spray - This is a general term referring to either a basal bark or a basal frill spray when applying a silvicide with a paint brush or sprayer to the basal portion of a tree or shrub. A basal bark spray is when the silvicide is applied directly to the uninjured bark whereas the basal frill spray refers to the application of the silvicide to frills around the circumference of the stem which have been cut diagonally into the tree with an axe.

Basic soil - A soil having the properties of a base, i.e. with a pH greater than 7 which will accept protons (hydrogen ions) from acid compounds.

Bottomland - The low lying land on both sides of a river, creek or lake which floods for a short time during the spring freshet or at other times of the year after a flash flood.

Calcareous soil - A soil which contains free calcium carbonate.

Clay - Generally lacustrine soil which contains over 40% of the particles that are less than 0.002 mm in diameter. As a soil textural class, soil material that contained 40% or more clay, less than 45% of sand and less that 40% of silt is classified as a clay soil.

Clone - A group of plants derived from a single individual (ortet) by asexual reproduction. All members of a clone are called ramets and have the same genetical make up and consequently identical characteristics.

Conifer - All trees bearing cones and needles or scale-like leaves and belonging to the order Gymnospermae.

Coppice - This term refers to basal sprouts arising from freshly cut stumps.

Cultivar - Any clone, race, chimera or the products of breeding deemed worthy of cultivation.

Cutting - A piece of plant stem or branch with one or more buds or a root which, when placed under suitable conditions, will produce roots and shoots resulting in a complete plant. The term cutting, which is used in the key, refers to both rooted and rootless cuttings from 0.9 m (3 ft) to 3.7 m (12 ft) in length and of sufficient length to permit them to be directly planted in the swamps and bottomlands.

Deer damage - Deer injure trees in the sapling and pre-polewood stage by browsing twigs, and by rubbing off bark with their antlers during the rutting season.

Dibble - A rod-like instrument varying in length from a few centimeters (inches) to 1 to 2 m (3-6 ft) and used to make a planting hole into which the stem of a tree, shrub or herb is inserted to the required planting depth.

Dieback - Progressive dying from the extremity of any part of a plant. For instance, the terminal growth of many hardwoods, if not properly programmed for the site, frequently die back following early fall and late spring frosts. The injury is evident during the following or current growing season respectively.

Early frosts - This expression refers to frosts which occur in the late summer or early fall before the wood of the current season has had a chance to harden. It often occurs on hardwoods growing on organic soils which, due to the availability of extra nitrogen, promote succulent growth into late summer and early fall.

Elevation - The height (m or ft) of a particular area, such as a swamp or hill, above sea level; which is taken as zero. This information is procured from contour maps published by the Canadian Department of National Defence and Survey Establishment.

Free lime - This term refers to calcium and/or magnesium carbonate deposits within a soil when they are not chemically combined with other elements. Its presence can be detected by bubbles of gas given off after the soil sample is treated with hydrochloric acid. The relative amount of free lime is indicated by the amount of effervescense after treatment with acid.

Frilling - This term refers to chopping vertical slits through the bark around the circumference of the tree. Silvicides may or may not be sprayed into the frills.

Growing Degree Days - Plant growth is dependent not only on the length of the growing season but also on the amount of heat available during this period. An index of the amount of heat is given by the seasonal accumulation of "Growing Degree Days" which is usually defined as the number of degrees of mean daily temperature above a base of 42°F (5°C).

Hand planting - Refers to planting rootless cuttings with a 1.0 - 1.5 m (3-5 ft) long dibble and to planting rooted cuttings or seedlings with a spade or shovel.

Hardwoods - A somewhat misleading but convenient term applied to trees with broad leaves belonging to the order Angiospermae.

Herbicides - These are chemical preparations used to kill or inhibit herbs and grasses. They are applied either directly to the plant as a contact herbicide (2,4-D amine) affecting the transpiration system (2,4-D amine) or the chlorophyll system (Gramoxone). They may also be applied to the ground as a soil sterilant (TCA) or as a preemergent chemical (Simazine). Perhaps one of the best herbicidal chemicals today is a systemic (Glyphosate). A systemic refers to all chemicals which are translocated through the plant.

Late frosts - Refers to frosts which occur in the spring after a warm period has stimulated initial growth.

Lowland - This term is used in the key to describe swamp and bottomland sites.

Machine planting - This refers to planting an area using a tractor-drawn planter such as a Lowther. This method can only be used in unmounded swamps, with little or no underbrush, that are not flooded at the time of planting.

Mounding - The act of turning a furrow to create a continuous elevated ridge of soil on which trees are to be planted.

Mouse damage - This injury is generally characterized by the complete or partial removal of an irregular band of bark 2-15 cm (1-6 in) wide around the base of the tree.

Plantation - A forest crop or stand raised artificially by sowing or planting.

Polyculture - Raising crops of several species in the same stand, generally even aged.

Progeny - This word refers to all descendants (offspring) of a particular plant.

pH - The pH is related to hydrogen-ion concentration in soils. It is dependent on the soil-water and the solid phase, i.e. the mineral and organic particles of the soil. The pH of the soil water system is an approximate reflection of the hydrogen-ion concentration of the soil solution. The pH can be measured with a device called a pH meter or with a chemical called phenolphthalein which changes colour depending on the pH of the soil solution. If the pH is 7 it is classified as neutral; if greater than 7 it is basic; and below 7 it is referred to as being acid.

Provenance - This term is used to indicate the geographic source of seed, seedlings, cuttings or scions of a particular species. Generally many provenances of a species are planted together to compare their growth and to identify and select superior individuals for propagation and for breeding studies.

Regeneration - The renewal of a tree crop, whether by natural or artificial means.

Rodenticides - Chemical compounds which are used to kill rodents. For mice the chemical is generally placed in quart-sized oil cans and for rabbits as a poisoned bait in apples or on aspen branches.

Scrub hardwoods - Conditions in some swamps are detrimental to tree growth resulting in undersized trees of some commercial species such as aspen, balsam poplar and black ash. One of the chief causes of poor growth in swamps is poor soil aeration, which can often be corrected by proper drainage.

Seedling - A tree, grown from a seed, which is younger and smaller than a sapling.

Shrub - A woody perennial plant smaller than a tree, usually with several stems.

Silvicides - A type of herbicide used to kill underbrush and trees and usually applied as a foliage or stem spray.

Silvics - The study of the life history and general characteristics of forest trees and stands. Silvical features usually refer to the characteristics of a particular tree species.

Silviculture - The science and art of cultivating forest trees from sowing or planting to harvesting.

Spacing - The distance between trees planted at regular intervals.

Stagnant site - Most of the hardwood swamps in southern Ontario are flooded for part or all of the growing season. However, a stagnant site is one which is flooded for most or all of the growing season resulting in anaerobic conditions as indicated by the strong odour of sulphur dioxide in the ecosystem.

Stocking - Number of trees per unit area. For instance, a 1.8 x 1.8 m (6 x 6 ft) spacing allows each tree 3.3 m^2 (36 ft^2), making a total of 2990 trees per hectare (1210 trees per acre).

Swamp - The terms swamp, bog and marsh are synonymous, referring to an area which is more or less permanently wet, having the water table at or above the soil surface. A swamp may support not only low vegetation such as sedges but also taller vegetation such as shrubs and trees. A pocket, saucer or a needle swamp in this report refers to their shape.

SCIENTIFIC AND COMMON NAMES OF TREES, SHRUBS AND SEDGES, MOSSES AND HERBS

Common name	Scientific name
Trees	
Balsam fir	*Abies balsamea* Mill.
Silver maple	*Acer saccharinum* L.
European alder	*Alnus glutinosa* (L) Gaertn.
White birch	*Betula papyrifera* Marsh.
Black ash	*Fraxinus nigra* Marsh.
Red Ash	*Fraxinus pennsylvanica* Marsh.
Eastern tamarack	*Larix laricina* (Du Roi) K. Koch
White spruce	*Picea glauca* (Moench) Voss
Black spruce	*Picea mariana* (Mill.) BSP
White pine	*Pinus strobus* L.
Balsam poplar	*Populus balsamifera* L.
Eastern cottonwood	*Populus deltoides* Marsh.
Trembling aspen	*Populus tremuloides* Michx.
Jackii poplar	*Populus jackii* Sarg.
European willow	*Salix alba* L.
Black willow	*Salix nigra* Marsh.
Peach leaf willow	*Salix amygdaloides* Anderss.
White cedar	*Thuja occidentalis* L.
American basswood	*Tilia americana* L.
American elm	*Ulmus americana* L.
Shrubs	
Red osier dogwood	*Cornus stolonifera* Michx.
Poison ivy	*Rhus radicans* L.
Dwarf willow	*Salix* spp.
Wild or fox grape	*Vitis riparia* Michx.
Sedges, Mosses and Herbs	
Swamp milkweed	*Asclepias incarnata* L.
Beggars tick	*Bidens connata* Muhl.
Sedges	*Carex* spp.
Spinulose wood-fern	*Dryopteris spinulosa* (O.F. Meull)
Joe pyweed	*Eupatorium maculatum* L.
Jewel weed	*Impatiens pallida* Nutt.
Huckleberry	*Gaylussacia dumosa* T & G
Labrador tea	*Ledum groenlandicum* Oeder
Cardinal flower	*Lobelia cardinalis* L.
Purple loosestrife	*Lythrum alatum* Pursh.
Sensitive fern	*Onoclea sensibilis* L.
Sphagnum moss	*Sphagnum* spp.
Cat-tail	*Typha latifolia* L.
Slender nettle	*Urtica gracilis* Art.
Blueberry	*Vaccinium* spp.
Wild grape	*Vitex riporia* Michx.

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